Project Report: The Use of Living Plants and Fossil Chemistry to Study the Morphological Patterns and Developmental Processes of Land Plant Evolution

Lead Team:	***Harvard University***
Project Title:	***The Use of Living Plants and Fossil Chemistry to Study the Morphological Patterns and Developmental Processes of Land Plant Evolution***

Project Progress

My research takes advantage of the unique opportunities of plants, including cellular preservation in fossils and the repeated evolution of similar morphological structures, to study the evolution of development and physiology in geologic time. Investigations of morphologically similar leaves in distantly related plant lineages have demonstrated that the evolution of convergent morphological patterns involves the evolution of convergent developmental processes and that morphological diversity through time has been shaped by developmental constraints. Current goals include: 1. hydraulic investigations of diverse leaf morphologies to determine how functional attributes have changed through time and, 2. the use of the morphological changes imposed during growth by environmental stresses, such as water deficits, to assess ecological parameters of fossil plants, such as the placement of the organism within the forest canopy.

Collaborative work with the Carnegie Astrobiology team involves the application of emerging techniques of fine−scale chemical analysis to the study of the physiology and biochemistry of fossil organisms. This research has allowed us to determine the original cell wall chemistry in the vasculature of the earliest fossil land plants despite extensive diagenetic alteration and to assess the contributions of different classes of biomolecules to the organic matter preserved in the rock record. Current goals include: 1. using the chemical characteristics of fossils to assess the biological affinities of enigmatic fossils, and 2. studying how the cell wall characteristics of vascular cells may have shaped the evolution of the tree habit across the single extant and several fossil examples of the evolution of woody tissues and secondary growth.

Highlights

- Convergent evolution of morphological patterns indicates convergent evolution of developmental processes in land plants.

- Submicron−scale layering of cell wall polymers were preserved intact in fossil plants hundreds of millions of years old.

Roadmap Objectives

- ***Objective No. 5:*** Linking Planetary Biological Evolution

Cross Team Collaborations

I am involved in an extensive, ongoing collaboration with members of the Carnegie Astrobiology team, George Cody, Marilyn Fogel, and Bob Hazen. Our work involves the application of emerging techniques of fine−scale chemical analysis to the study of the physiology and biochemistry of fossil organisms. This research has allowed us to determine the original cell wall chemistry of the earliest fossil land plants despite extensive diagenetic alteration and to assess the contributions of different classes of biomolecules to the organic matter preserved in the rock record. Current goals include using the chemical characteristics of fossils to assess the ecological settings of fossil plants and the biological affinities of enigmatic fossils.